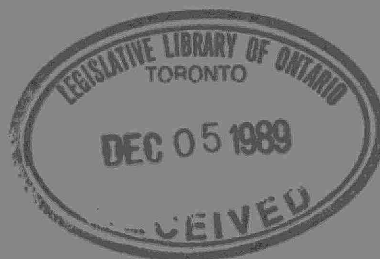


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OF MONITORING VEGETATION
IN THE VICINITY OF
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BAYVIEW AVENUE, TORONTO
1972 to 1986

JULY 1989



Environment
Ontario

Jim Bradley
Minister

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RESULTS OF FIFTEEN YEARS OF MONITORING VEGETATION
IN THE VICINITY OF BRAMPTON BRICK, BAYVIEW AVENUE, TORONTO
1972 to 1986

Phytotoxicology Section
Air Resources Branch
Dr. W. D. McIlveen

ARB-052-88-Phyto

JULY 1989



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INTRODUCTION

In 1972, the Phytotoxicology Section, Air Resources Branch began to monitor the effects of emissions from Brampton Brick (formerly Toronto Brick) on vegetation growing in proximity to the brickyard. The monitoring has continued annually except in 1974 and 1978. This report summarizes the data collected over the period 1972 to 1986.

THE SOURCE

The Brampton Brick operation is located on the west bank of the Don River approximately 1 km north of Danforth Avenue, Toronto. It was built approximately 90 years ago to take advantage of on-site clays which are suitable for the manufacturing of building bricks. Fluoride is emitted as an industrial by-product from the operation of the kilns.

SURVEILLANCE ACTIVITIES

In 1972, six locations in the vicinity of the Brampton Brick plant were selected for monitoring of vegetation to determine if emissions from the operation were having an environmental impact. A seventh location was added in 1974. These sampling stations were chosen to correspond with locations where fluoridation lime candles had been exposed to monitor airborne fluoride.

In 1976, the survey was expanded to 9 locations which included 5 of the previously established stations. A tenth station was added in 1977. The locations of the 10 stations are indicated in Figure 1. No surveillance activities were undertaken in 1975; however, a special study was undertaken in 1978 (see below). The sampling program was continued until 1986.

At each established station in the late growing season, the vegetation was examined and evaluated for injury. Any symptoms of disease, insect or air contaminant were recorded. Samples of foliage from maple trees (or elm at Site 8) were collected for chemical analysis. The samples were brought to the Phytotoxicology Laboratory where they were sub-divided, washed,

oven-dried, ground in a Wiley-mill and stored in glass jars. They were then analyzed for their fluoride content on a washed and unwashed basis using standard analytical techniques by the Inorganic Trace Contaminants Section of the Ontario Ministry of the Environment Laboratory at Resources Road.

VISUAL OBSERVATIONS

Typical fluoride toxicity injury to foliage of sensitive vegetation species was observed in most years in close proximity to the brickyard. The available data for recorded injury to Manitoba maple and wild grape are summarized in Table 1. Injury was also noted at individual locations on other sensitive species such as silver maple, false Solomon's Seal, amur maple, wild rose, St. John's wort and Hosta lily.

The amount of injury varied from year to year (Table 1) at any given station. Injury was found to be most regular and most severe at Stations 1, 8 and 9 which are located nearest to the brickyard in the south and east directions. No injury which was attributable to fluoride toxicity was noted in any years at Stations 7 and 10 which are the most remote from the indicated source. The frequency and severity of injury at the other stations was sporadic and only trace to light in degree.

FLUORIDE IN VEGETATION

i) General Pattern - 1972 to 1984

The fluoride content of the foliage each year is summarized in Table 2. There is a considerable fluctuation in the concentrations measured each year with a particularly noticeable decrease in 1980 and 1982 at Station 8. The reason for this decrease is not known; however, the fact that foliar injury on nearby maple and wild grape in these 2 years did not display a similar decrease would suggest that the chemical data for these 2 years are not representative of fluoride exposure at this site. In all years since sampling began, the highest fluoride concentrations were encountered at

Stations 8,9 and 1, respectively, which are located nearest to the source. The values for the unwashed samples at these three locations all exceeded the Upper Limit of Normal for background concentration of fluoride in foliage in urban areas (35 ug/g).

Prior to 1981, particularly in the period 1976 to 1979, the fluoride values exceeded background on several occasions at all other locations except Station 5. The only recent exceedances (excluding Stations 1, 8, and 9) were in 1983 and 1984 at Station 4.

ii) 1985 Collections

At most locations, the fluoride values measured in 1985 were similar to those encountered in previous years. The exceptions to this occurred at Stations 1, 8 and 9. At Station 1, the fluoride content of unwashed silver maple foliage was at the highest level since 1979, although the washed sample contained generally similar amounts observed in recent years. By contrast, the fluoride values for both washed and unwashed samples of elm foliage collected at Station 8 dropped noticeably and were lower than in any previous year except 1980 or 1982. In 1982, brick production was terminated during the growing season. At Station 9, silver maple foliage showed fluoride values of 222 and 116 µg/g F in unwashed and washed samples, respectively. These values were the highest since about 1979 and are approximately three times greater than those measured at the same location in 1984. An individual sample of wild grape foliage taken at Station 8 contained 84 µg/g F.

iii) 1986 Collections

The fluoride concentration of samples collected in 1986 was lower than corresponding 1985 values. The minor exceptions to this finding were slight increases in washed foliage at Stations 2,7 and 8. The highest value was obtained for the elm foliage at Station 8; however, the values for 1985 and 1986 are less than half of that measured in 1984.

iv) Accumulation of Fluoride

In almost all cases, washing of the samples resulted in fairly small decreases in fluoride content of the foliage samples, suggesting that the emissions were predominantly gaseous in nature and capable of entering the leaf tissue. However, as approximately one quarter of the fluoride could be removed by washing, it is possible that at least some of the fluoride was particulate in nature (or absorbed onto particulates) and external to the foliage. The relative internal and external fluoride content of foliage collected at each station is shown in Figure 2.

A trend to lower fluoride concentrations in unwashed samples collected in recent years is illustrated in Figure 3. Mean concentrations of fluoride were calculated for samples at each station for the period up to and including 1980 and for the period 1981 to 1986. The figure illustrates that the concentrations recorded in the more recent period were only about one half of those encountered in the earlier period.

Annual fluctuations in the fluoride content of unwashed samples at the three most heavily impacted sampling stations are shown in Figure 4. The greatest changes and the highest concentrations were associated with elm foliage collected at Station 8. By comparison, the concentrations measured at the other two locations were more stable; however, there was a slight decrease to 1982, followed by a general increase in more recent years.

v) Daily Sampling Study - 1978

In order to determine patterns of daily accumulation of fluoride in vegetation growing in the vicinity of Brampton Brick, an experiment was undertaken in 1978. Between June 2 and July 2, 1978, triplicate samples of Manitoba maple and grass foliage were collected on 25 days at 3 sites as shown in Figure 5. The samples were processed and analyzed as described for the regular sampling program. Precipitation data was obtained at 315 Bloor Street West, Toronto.

The data collected during this study are included in Table 3. Although strong fluctuations are apparent in the data, particularly in the unwashed foliage, there was a steady increase in the fluoride content of both sampled species during the 1 month sampling interval. Data for washed maple and unwashed grass at the site which corresponds with that of Station 9 in the regular program are presented in Figure 6. This study emphasizes the care which must be taken in interpreting data based on single collection of foliage since variability can be introduced by:

- 1) day to day changes in fluoride concentration related to growth of the plants
- 2) precipitation quantity and timing relative to collection data
- 3) site variability
- 4) sample selection and collection
- 5) processing of samples
- 6) analysis of samples

In this study, the forage samples consistently contained higher amounts of fluoride than did the maple.

SUMMARY

Since 1972, the Phytotoxicology Section of the Ontario Ministry of the Environment has conducted annual surveys (except 1975 and 1978) to determine the effects of emissions from the Brampton Brick operation at Bayview Avenue, Toronto on vegetation in the area. Light to moderate injury to sensitive species such as wild grape, Manitoba maple and silver maple was recorded regularly in the vicinity of the operation. Most of the injury was restricted to an area within 500 m south and east of the kilns. This zone also included the sampling stations where highly elevated concentrations of fluoride were measured in tree foliage. Although still elevated in 1985 and to a lesser degree in 1986, the fluoride content of vegetation in most cases was found to be lower in recent years when compared with those prior to 1980. This reduction pattern did vary from

site to site and from year to year. The nature of this variability was explored more closely in 1978 with daily foliar sampling and comparison with rainfall data at 3 sites in the vicinity of the brick works.

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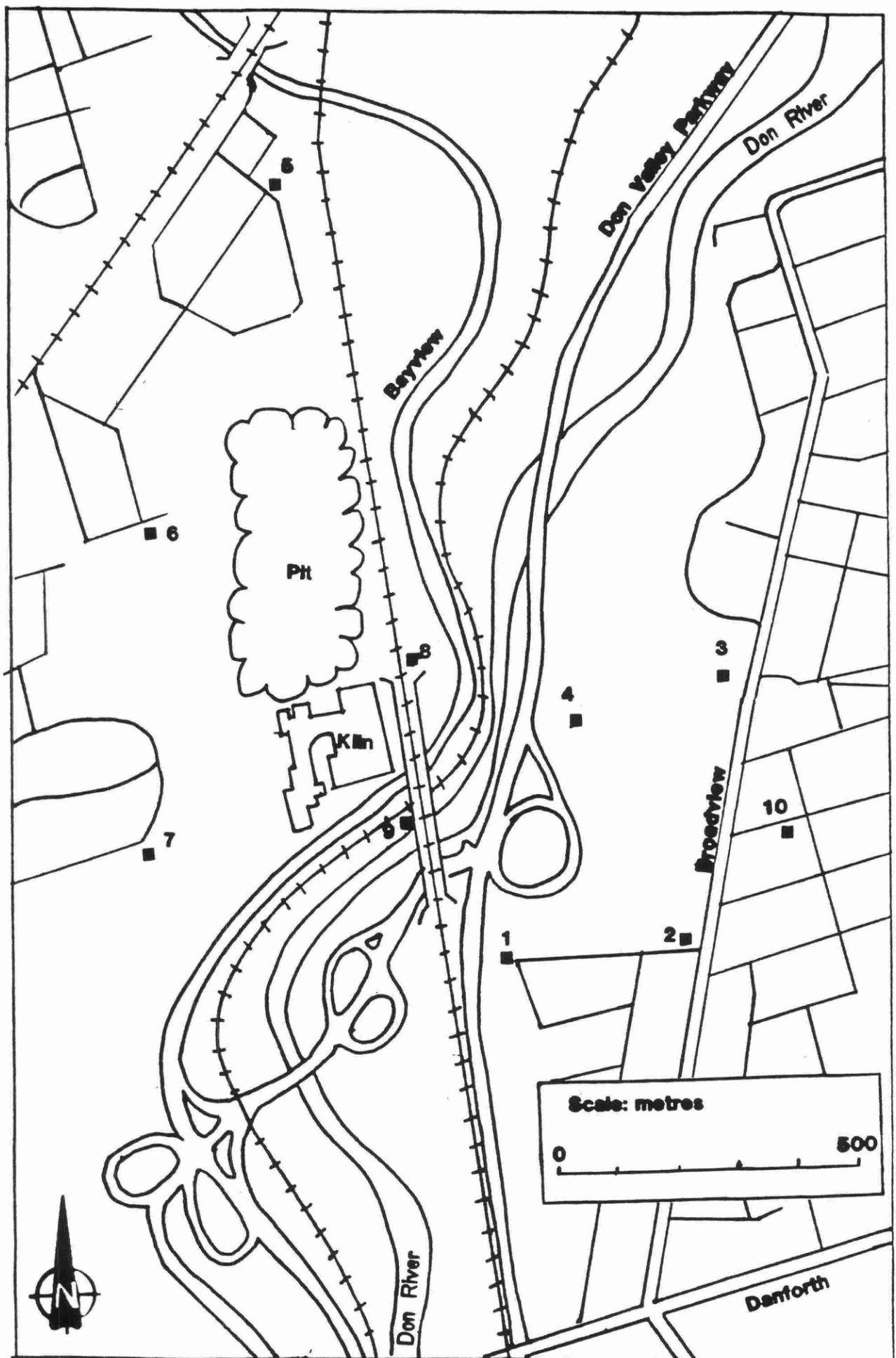


Figure 1. Vegetation sampling stations in the vicinity of Brampton Brick, Toronto, 1972-1986

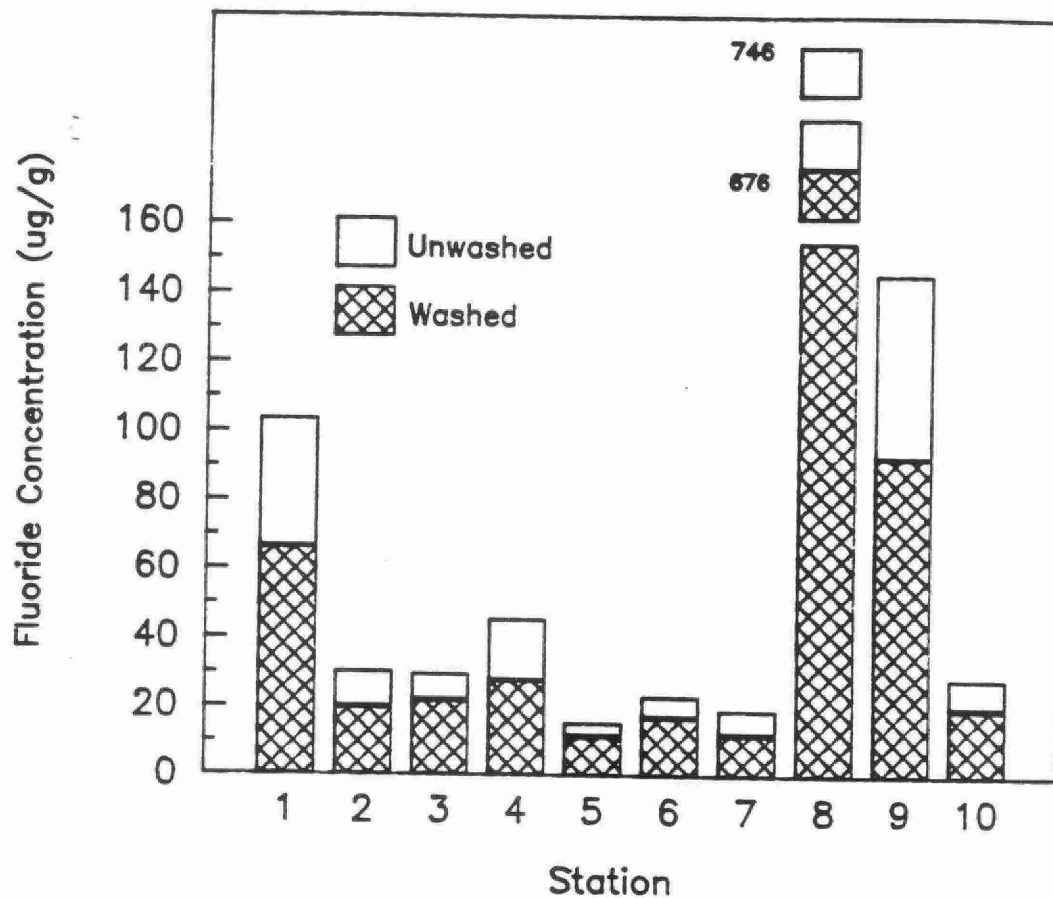


Figure 2. Comparison of mean fluoride concentrations in maple and elm washed and unwashed foliage at 10 sample stations in the vicinity of Brampton Brick, Toronto. 1972-1986

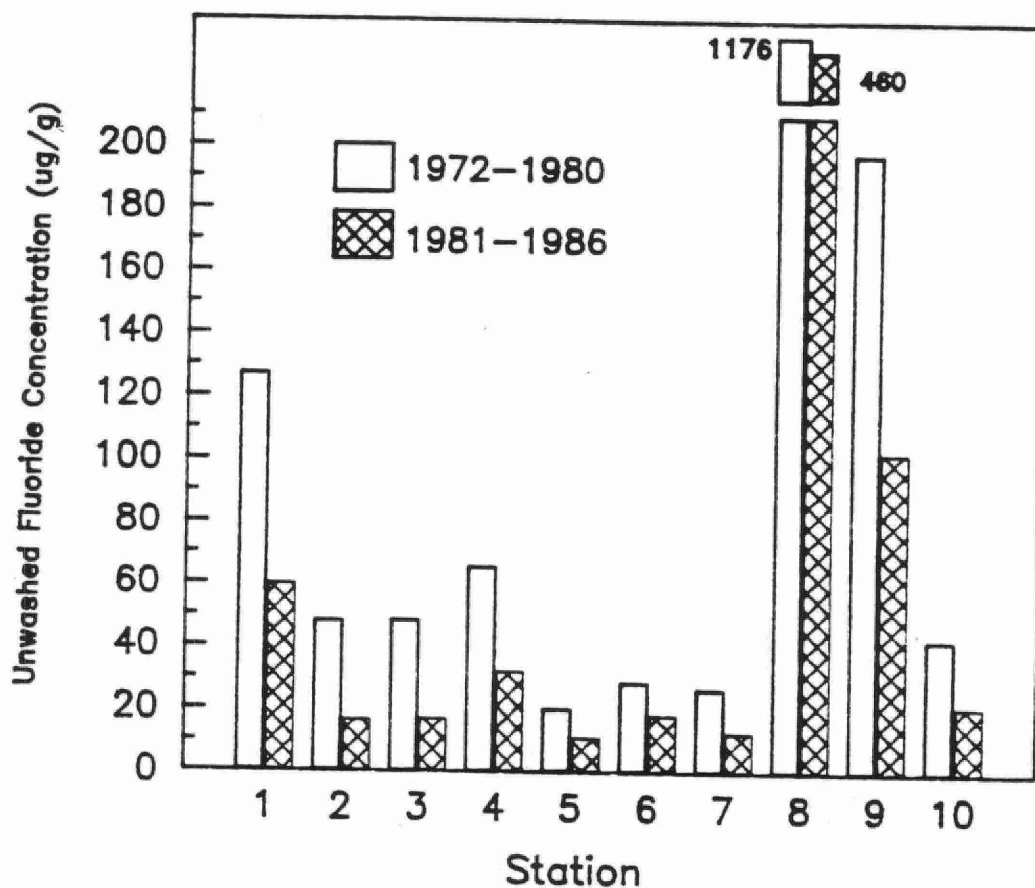


Figure 3. Comparison of fluoride concentrations in unwashed maple and elm foliage in two time periods (1972-80 and 1981-86) at 10 sample stations in the vicinity of Brampton Brick, Toronto

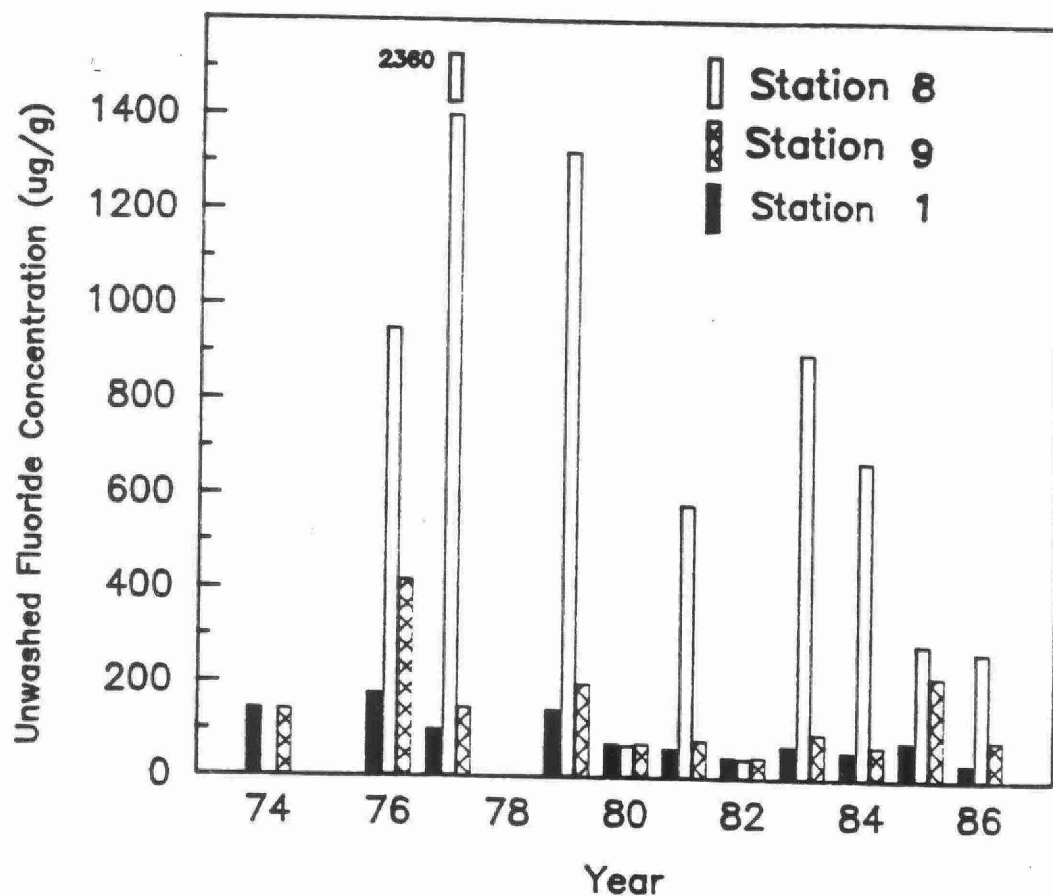


Figure 4. Annual fluoride concentrations in unwashed maple and elm foliage collected at the three most heavily impacted sampling stations in the vicinity of Brampton Brick, Toronto. 1974-1986

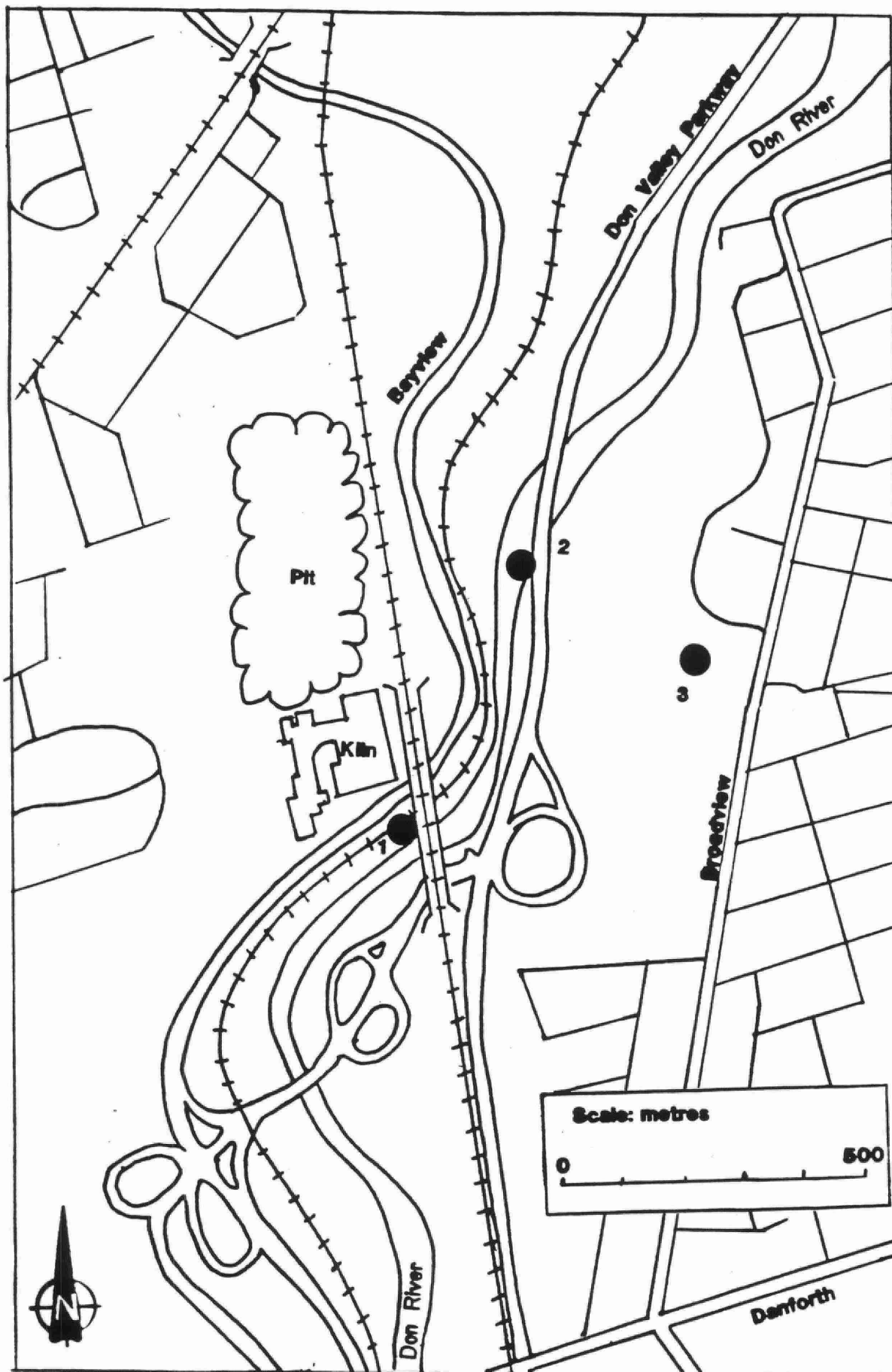


Figure 5. Locations of sampling sites for daily fluoride monitoring in maple and grass foliage in the vicinity of Brampton Brick, Toronto. June and July, 1978

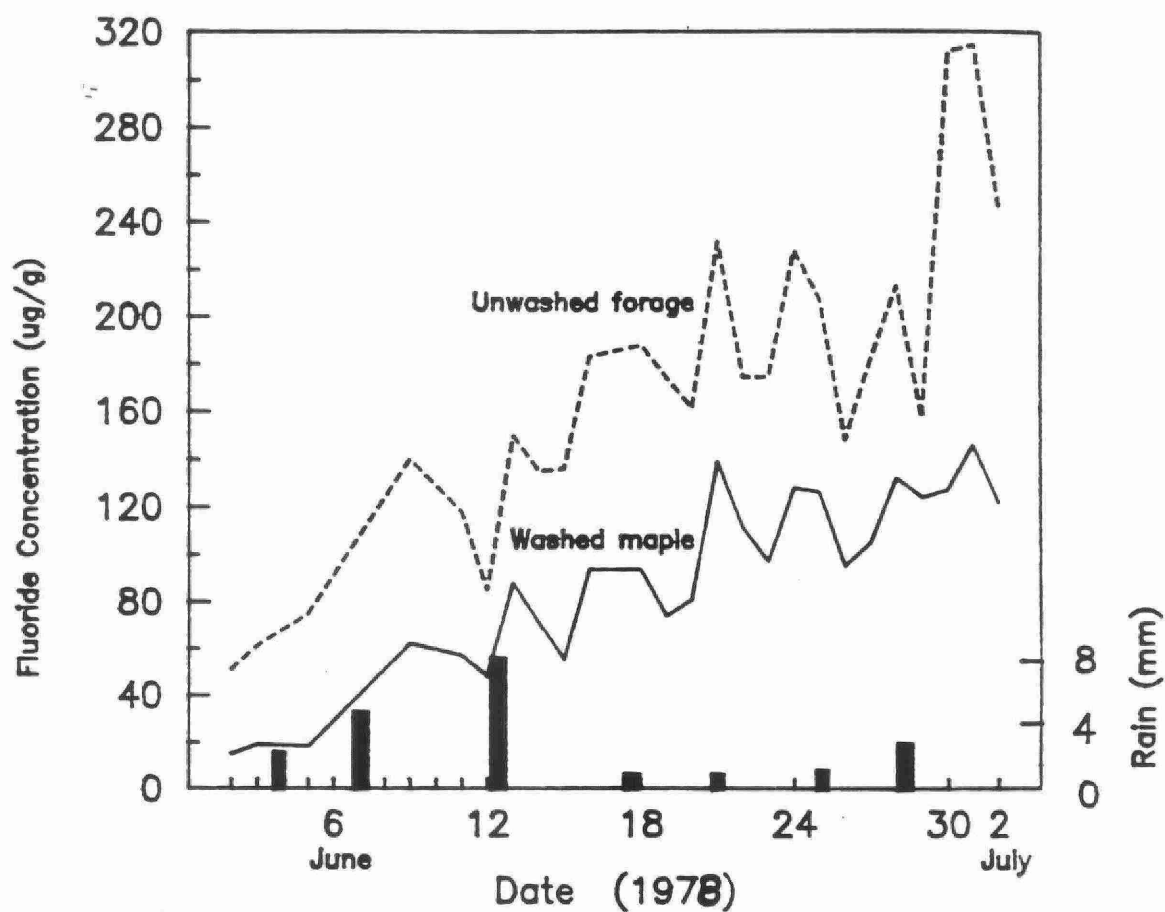


Figure 6. Daily fluoride concentrations in forage and maple foliage and comparison with rainfall in the vicinity of Brampton Brick, Toronto. June and July, 1978 (Data for Site 1 only)

TABLE 1
Severity of Fluoride Injury* to Manitoba Maple and Wild Grape Foliage Noted at Observation Stations
Located in the Vicinity of Brampton Brick from 1972 to 1986

Station	Location	Species	Year												
			1972	1973	1974	1976	1977	1979	1980	1981	1982	1983	1984	1985	1986
1	420 m SE	Maple Grape	Tr-Lt Tr-Lt	Tr-Lt Tr-Lt	Tr Tr	None None	- Tr	Tr-Lt Lt	Tr Tr	Lt Lt-Mod	- Lt-Mod	Lt-Mod Lt	- Tr	Tr**	Tr
2	575 m SE	Maple Grape	- -	- -	- -	None	None	None	None	Tr -	None	None	None	None	Tr
3	550 m E	Maple Grape	- -	- -	- -	None	None	None	None	Tr-Lt** Tr	None	None	None	None	Tr
4	375 m E	Maple Grape	- -	- -	- -	None	None	Tr -	Tr -	Tr-Lt Tr-Lt	-	None	None	None	Tr-Lt
5	700 m N	Maple Grape	None	None	None	None	None	None	Tr	None	None	None	None	None	Tr-Lt
6	485 m NW	Maple Grape	None	None	None	None	None	Tr -	Tr Tr	Lt Lt	None	- Tr-Lt	None	None	Tr
7	410 m W	Maple Grape	None	None	None	None	None	None	None	None	None	None	None	None	Tr
8	100 m N	Maple Grape	- -	- -	- -	None	- Tr	Tr-Lt Lt	Tr-Mod Lt-Mod	Tr-Mod Tr-Mod	- Lt-Mod	- Lt-Mod	- Lt	Lt	Lt
9	100 m SE	Maple Grape	Tr-Lt Tr-Lt	Tr-Lt Tr-Lt	Mod-Sev Mod-Sev	None	- Tr	Tr Lt-Mod	Tr** Tr	Tr Lt-Mod	- Tr-Lt	Lt -	- Tr	Tr** Lt-Mod	Tr-Lt
10	730 m E	Maple	-	-	-	-	None	None	None	None	None	None	None	None	Tr

*Tr = Trace, Lt = Light, Mod = Moderate, Sev = Severe
(>0-1%) (2-10%) (11-35%) (>35%)

**Silver maple

TABLE 2
Fluoride Concentrations ($\mu\text{g/g}$ dry weight) in Vegetation Foliage Samples Collected at Ten Stations
in the Vicinity of Brampton Brick, Toronto, from 1972 to 1986

Station	Location	Species*														
				1972	1973	1974	1976	1977	1979	1980	1981	1982	1983	1984	1985	1986
1	420 m SE	Silver Maple	NW W	75	- 37	144 77	177 164	100 92	143 103	73 50	63 62	46 31	71 55	60 29	83 54	37 33
2	575 m SE	Silver Maple	NW W	-	-	-	74 47	46 35	33 21	40 23	43 20	10 10	16 9	15 12	14 9	13 12
3	550 m E	Silver Maple	NW W	-	-	-	64 55	51 31	44 31	35 10	26 26	18 16	12 11	19 19	18 13	10 7
4	375 m E	Manitoba Maple	NW W	-	-	-	109 105	62 50	64 28	28 10	31 19	14 6	63 14	44 19	23 15	18 12
5	700 m N	Silver Maple	NW W	12	- 10	9 5	26 20	24 19	25 24	18 9	16 14	5 3	8 9	12 7	19 13	8 6
6	485 m NW	Silver Maple	NW W	22	- 21	26 5	36 32	17 15	52 44	13 10	14 11	21 18	20 14	24 12	19 10	13 9
7	410 m W	Silver Maple	NW W	12	- 8	9 5	50 31	21 15	41 28	13 8	18 12	16 10	10 10	7 5	18 7	9 8
8	100 m N	American Elm	NW W	-	-	-	950 859	2360 2480	1323 1190	70 55	581 478	44 29	900 600	674 625	288 207	272 238
9	100 m SE	Silver Maple	NW W	42	- 55	144 103	421 288	149 123	200 142	75 33	83 69	48 45	100 77	74 42	222 116	89 73
10	730 m E	Silver Maple	NW W	-	-	-	-	49 34	40 27	39 18	26 24	35 16	14 11	20 22	18 14	17 13
Phytotoxicology Upper Limit of Normal for Urban Unwashed Foliage			NW	 35												

*NW = not washed, W = washed

TABLE 3
Mean Daily Fluoride Concentrations in Maple and Grass Samples Collected
in the Vicinity of Brampton Brick, Toronto 1978

Sample Date		Site 1				Site 2				Site 3			
		Maple		Grass		Maple		Grass		Maple		Grass	
		NW	W	NW	W	NW	W	NW	W	NW	W	NW	W
June	2	54	15	51	37	11	5	5	6	12	4	8	5
	3	130	19	61	35	10	4	7	5	15	7	8	6
	5	110	18	75	56	10	7	6	4	5	5	5	4
	9	156	62	140	96	11	6	6	4	6	3	6	3
	11	149	57	118	88	10	6	6	5	8	4	7	8
	12	116	48	85	86	19	9	22	12	9	5	7	5
	13	166	88	150	147	15	8	11	12	4	4	5	4
	14	149	71	135	110	18	6	9	8	8	5	7	4
	15	121	55	136	96	11	7	8	6	6	3	9	10
	16	108	94	183	152	10	6	12	7	11	9	16	10
	18	146	94	188	150	10	7	5	4	9	4	12	9
	19	109	74	174	152	9	7	9	8	12	8	11	10
	20	178	81	161	164	13	8	8	7	14	7	15	12
	21	278	139	232	185	12	9	12	8	13	8	9	7
	22	187	111	174	154	17	6	12	9	18	10	15	14
	23	211	97	174	143	12	8	11	11	15	7	13	9
	24	242	128	228	228	25	10	13	9	20	10	12	14
	25	270	126	207	158	7	5	11	8	11	7	16	10
	26	199	95	148	149	13	7	11	5	19	10		
	27	258	105	182	155	15	6	28	15	14	4	7	4
	28	287	132	213	160	17	6	14	10	23	16	19	16
	29	198	124	157	123	18	5	9	5	11	10	18	9
	30	353	127	312	201	16	5	17	10	22	9	16	8
July	1	237	146	315	220	11	4	20	9	27	12	28	15
	2	298	122	247	172	14	7	12	11	18	10	15	13



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